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Amplifying Signals and avoiding surprises: Potential synergies between ICOS and eLTER at the Water-Climate-Greenhouse Gas nexus

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Environmental thresholds. tipping points and subsequent regime shifts associated with the water/climate/greenhouse gas nexus pose a genuine threat to sustainability. Both the ongoing forest dieback in Central Europe caused by the extreme droughts of the last years and the effect of global warming on ecosystem functioning have the potential to cause ecological surprise (*sensu* Lindenmayer et al. 2010) where ecosystems are pushed into new, unexpected and usually undesirable states.

Formulating appropriate scientific and societal responses to such regime shifts requires breadth, depth, intensity and duration of environmental, ecological and socio-ecological monitoring. Broad geographic coverage to encompass relevant biophysical and societal gradients, consideration of all appropriate parameters, adequate measurement frequency and long-term, standardized observations are all needed to provide reliable early warnings of severe environmental change, test ecosystem models, avoid double counting in carbon accounting and to reduce the likelihood of undesirable ecological outcomes. This is especially true of events driven by simultaneous changes in climate, the water cycle and human activities.

Well-supported, site-based research infrastructures (RIs; e.g., eLTER and ICOS) are essential tools

with the necessary breadth, depth, intensity and duration for early detection and attribution of environmental change. Individually, the eLTER and ICOS RIs generate a wealth of data supporting the ecosystem and carbon research communities. Achieving synergies between the two RIs can add value to both communities and potentially offer meaningful insight into the European water-climate-greenhouse gas nexus.

The unique insights into processes and mechanisms of ecosystem dynamics and functioning obtained from high intensity monitoring conducted by the ICOS RI greatly increase the likelihood of detecting signals of environmental change. These signals must be placed into the context of their long-term trajectory and potential societal and environmental drivers. The spatially extensive, long-term, multi-disciplinary monitoring conducted at LTER sites and LTSER platforms under the umbrella of the eLTER programme can provide this context.

Here, we outline one potential roadmap for achieving synergies between the ICOS and eLTER RIs focussing on the value of co-location for improved understanding of the water/climate/greenhouse gas nexus. Based on data and experiences from intensively studied research sites, we highlight some of the possibilities for reducing the likelihood of ecological surprise that could result from such synergies.

Lindenmayer, D.B., Likens, G.E., Krebs, C.J. and Hobbs, R.J., 2010. Improved probability of detection of ecological “surprises”. Proceedings of the National Academy of Sciences, 107(51), pp.21957-21962.